FOOD, GROWTH AND SEXUAL DIMORPHISM OF THE REDSIDE DACE *CLINOSTOMUS ELONGATUS* (KIRTLAND) IN LINESVILLE CREEK, CRAWFORD COUNTY, PENNSYLVANIA[1]

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Kirtland described in 1836 an attractive and widely distributed cyprinid, the redside dace, *Clinostomus elongatus.* It is surprising that since that time researchers have given little or no attention to this species. Koster (1939) published a brief work on its life history and Evans and Deubler (1955) studied tooth replacement. Greeley (1927, 1936), on the basis of one or two specimens, comments that this species feeds on insects and will rise to an artificial fly. Breder (1920a, 1920b) and Deubler's unpublished thesis (1955) remain the only other works involving a member of this genus, *Clinostomus vandoisulus.*

As a result of this paucity of literature, it was decided to investigate further the life history of the redside dace. This study includes: 1) a general food study of specimens taken from the same creek; 2) a comparison of food consumed by the young and adults; 3) the role of age in food preference; 4) supplementary information on sexual dimorphism and growth rates.

MATERIAL AND METHODS

Two hundred and thirty-four specimens of the redside dace were collected in seven samples during 1955. At least 10 specimens were taken each month except when collecting was made impossible by ice, high waters, or inclement winter weather.

The method of food study consisted of examining the stomach contents of each fish and estimating visually the percent volume of each group of food present. Samples which contained material that could not be identified were mounted on glass slides for later study.

Measurements taken of the standard length, head length and pectoral length followed the methods of Hubbs and Lagler (1947). The age was determined by removing scales from the area just below the dorsal fin and dorsad to the lateral line. Less difficulty was found with redside scales than was experienced by Breder (1920a) with *C. vandoisulus* scales. Individual fish were weighed on a triple beam balance, accurate to 0.01 gm. Sex determinations consisted of noting the size and shape of the anal papilla, length of the pectoral and pelvic fins, and body coloration, verifying the determination by an internal examination of the gonads.

HABITAT

Linesville Creek is a small, gravel, mud and sand-bottom creek located at Linesville, Crawford County, Pennsylvania, approximately 10 mi east of the Ohio-Pennsylvania border. This stream flows through fields and pastures and drains into Pymatuning Lake whose outlet flows into the Shenango River, Ohio drainage. The stream varies in depth from one to three ft and has an average width of 30 ft. The redside dace in Linesville Creek is found in pools with a

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gravel-sand bottom having a depth of two ft. It is known to spawn in this type of habitat (Koster, 1939).

FOOD

In their natural habitat, as well as in aquaria, the redside dace readily jump several inches into the air to catch a hovering insect. This jumping, coupled with a large mouth and the vigorous swimming activities of this species, suggested that this fish was a mid-water or surface feeder.

TABLE 1

Food of Clinostomus elongatus *(Kirtland), by months, expressed as percentage frequency of occurrence and volume*

Month	March		April		May		June		July		August		October		Total	
Percentage frequency (F) and Volume (V)	(F)	(V)	(F)	(V)	(F)	(V)	(F)	(V)	(F)	(V)	(F)	(V)	(F)	(V)	(F)	(V)
Insects																
Ephemeroptera	17.4	14.0	5.5	2.0	5.6	3.0	6.0	5.5							7.6	3.9
Odonata									40.0	12.0					5.0	1.7
Plecoptera			3.0	0.8											1.0	.1
Thysanoptera									7.0	1.0					1.0	.1
Hemiptera																
Heteroptera							3.0	5.0					8.0	1.0	18.7	.9
Homoptera	12.6	7.0	8.3	2.0	14.6	6.0	15.1	9.0	40.0	5.0	8.7	7.0	8.0	3.0	16.7	5.6
Neuroptera					1.1	1.3									1.0	1.1
Hymenoptera																
Ichneumonidae					2.0	0.3					4.3	13.0			18.8	1.9
Formicidae	4.3	2.0	8.3	2.0	9.8	4.0	3.0	6.0	14.0	11.0	8.7	13.0	31.0	23.0	10.0	8.8
Other					1.1	0.1	12.0	1.0	20.0	25.0	8.7	10.0	31.0	23.0	8.5	7.1
Coleoptera																
Curculionidae					9.0	16.0									17.3	2.3
Other	12.6	4.0	14.0	2.0			9.0	6.0	27.0	28.0	8.7	11.0	46.0	23.0	11 9	10.6
Lepidoptera					3.0	2.0									1.5	.3
Diptera																
Pupae	4.3	19.0	88.8	59.4	4.5	0.6									18.8	11.2
Adults																
Empididae					16.9	9.0									7.6	1.3
Other	35.0	8.0	41.4	21.4	5.6	23.0	33.0	26.5	30.0	9.0	13.0	14.0	23.0	5.0	24.5	15.2
Eggs (Insect)?					1.1	.04	3.0	1.0			4.3	1.0			1.5	.3
Unidentifiable remains	65.2	42.0	22.2	10.0	67.4	34.0	33.0	18.0	20.0	9.0	17.0	30.0	54.0	15.0	55.0	22.6
Material other than insects																
Arachnida	4.3	3.0					12.0	16.0					31.0	3.0	4.6	3.1
Hydracarina			14.0	0.2	18.0	0.3									10.5	.1
Nematoda			11.1	0.2	7.8	0.1									6.0	.04
Plants					4.5	0.3	9.0	6.0							4.0	.9
Debris (Inorganic)	4.3	1.0													1.0	.01
Total																99.15
Total Specimens Male/ Female	8/17		15/21		13/76		11/22		1/14		2/21		0/13		234	
Total Stomachs Full	0/1		2/4		1/9		2/2		0/0		0/2		0/2		25	
Total Stomachs Empty	0/1		2/1		0/7		5/7		1/6		1/7		0/0		38	
Total Stomachs Partly Full	8/15		11/16		12/60		4/13		0/8		1/12		0/11		171	

The food data, summarized by months in table 1, substantiated this conclusion. Insects comprised 95.00 percent of the total food, by volume. Terrestrial insects made up 76.9 percent of the total. Seventeen percent of the total volume consisted of bottom forms such as diptera pupae (11.2), Ephemeroptera (3.9) and Odonata (1.7) with traces of other bottom insects. The remaining five percent

of the total food eaten was composed largely of Arachnids (3.0), while Hydracarina, Nematoda, plants and debris contributed a little more than one percent to the redside diet. Plankton was not found in any of the stomachs; however, one stomach was found containing a quantity of debris which consisted of mud and wood particles.

Diptera pupae and adults, comprising 27.7 percent by volume and 50.9 percent by frequency, were the most common insects found in redside stomachs. Other orders of insects found in the stomachs occurred in approximately the following sequence by percent volume: Hymenoptera (17.8), Coleoptera (12.9), Hemiptera (6.5), Ephemeroptera (3.9), Odonata (1.7), Neuroptera (1.1), while Lepidoptera, Plecoptera and Thysanoptera all appeared less than one percent of the time. By frequency of occurrence the same order existed as for volume (table 1). Eggs (insects ?) formed 0.3 percent of the food. These eggs were always found in close proximity with insect abdomens and were, therefore, considered to be of that insect's origin. Unfortunately, unidentifiable insect remains, fragments of legs, eyes, thorax or unknown immature insect stages, made up a large percentage (22.6) of the total insect food.

TABLE 2

Food of Clinostomus elongatus *(Kirtland), by age class, expressed as percentage of frequency of occurrence and volume*

Percentage Frequency and Volume	1 yr. (F)	1 yr. (V)	2 yr. (F)	2 yr. (V)	3 yr. (F)	3 yr. (V)	4 yr. (F)	4 yr. (V)	Total (F)	Total (V)
Insects										
Ephemeroptera	6.7	3.2	5.3	2.2	12.6	7.2	40.0	20.0	7.6	3.9
Odonata					4.6	3.8			5.0	1.7
Plecoptera			1.7	0.4					1.0	.1
Thysanoptera			1.7	0.2					1.0	.1
Hemiptera										
Heteroptera					9.0	4.0			18.7	.9
Homoptera	11.2	5.4	17.3	7.8	9.0	5.0	40.0	7.5	16.7	5.6
Neuroptera			1.7	1.3					1.0	1.1
Hymenoptera										
Ichneumonidae	1.0	0.9	7.0	2.5					18.8	1.9
Formicidae	6.7	2.2	19.4	10.5			20.0	6.7	10.0	8.8
Other	2.4	3.0	7.0	6.7	9.0	3.2	40.0	14.0	8.5	7.1
Coleoptera										
Curculionidae	6.0	0.4	3.5	1.0	18.1	4.5	20.0	4.0	17.3	2.3
Other	10.1	8.9	26.3	14.1	18.0	9.2			11.9	10.6
Lepidoptera	2.5	1.3	1.7	.3					1.5	.3
Diptera										
Pupae	18.6	14.9	19.3	9.6	9.0	6.6	20.0	8.0	18.8	11.2
Adults										
Empididae	10.1	4.8	1.7	.01	12.6	1.1			7.6	1.3
Other	39.0	22.6	42.1	16.5	18.1	7.4	40.0	18.0	24.5	15.2
Eggs (Insect)?			1.7	0.4	4.6	0.8			1.5	.3
Unidentifiable remains	62.5	30.0	36.8	21.7	60.0	39.0	40.0	19.0	55.0	22.6
Material other than insects										
Arachnida	9.0	1.5	3.5	3.0	9.0	3.6			4.6	3.1
Hydracarina	11.0	0.2	3.5	0.1	9.0	0.1	20.0	0.3	10.5	.1
Nematoda	6.7	.09	3.5	0.1	4.6	0.2			6.0	.04
Plants			3.5	0.5	4.6	4.3	20.0	2.5	4.0	.9
Debris	0.9	.01							1.0	.01
Total										99.15

There was a seasonal difference in the quality and quantity of food consumed (table 1). Diptera pupae (19%) and Ephemeroptera nymphs (14%) were eaten in the greatest quantity in March, compared to a yearly average of 11.2 and 3.9 percent, respectively. In subsequent months, stomach contents showed a gradual increase in food size and quantity, from larval and small adults to primarily large adult insects. The fishes' preference for Diptera, which composed 32.6 percent of the food volume for May, decreased throughout the summer and fall months as more of the larger Coleoptera and Hymenoptera were eaten. A peculiar point to note here was the presence of Ephemeroptera during the period from April through June in the stomach contents of the redside dace. This leads one to suspect this group of being a secondary source of food, during the period from October to March when winged forms are absent.

It was apparent that the size of food was an important factor in its utilization (table 2). There was a general increase in the size of food organisms consumed as the size of the fish increased. This difference was noted by Forbes (1878, 1880) and Breder and Crawford (1922) for other cyprinids. Year-group 1 (terminology follows Rounsefell and Everhart, 1953) fed mostly on small Diptera (42.3% by volume, table 2) and a few Coleoptera and Hemiptera (*Aphrophora carotogensis* and *Philaenus leucophthalmus*). Specimens of year-group 2 consumed Coleoptera (9.3–15.1%) and Hymenoptera (6.1–19.7%) in preference to Diptera 42.3–26.1%). Specimens in year-group 3 were noted to also prefer, by volume, adult Coleoptera (13.7%) and Hemiptera (9.0%) to Diptera (8.5%). Although year-group 4 fish were noted to have eaten large quantities of Ephemeroptera (20%), Diptera (26.0%) and Hymenoptera (20.7%), the small number of fish and the season of their capture (March, May, and October) lessened the true importance of these forms as food for this year-group.

SCALE FORMATION AND DESCRIPTION

Clinostomus scale annuli are laid down before October 25 since specimens taken after October 25 show occasional additional circulae development. However, circulae production can be evident on specimens taken as early as March 4.

Annuli can best be distinguished in the scale's anterior field as a clear zone between two circulae. This annulus can be traced within the anterior field of the scale and is not delineated (Lagler, 1950) by cutting-over but by a running-together of circulae adjacent to the annulus zone laterally. This produces one prominent circulus which then traverses the posterior field, bifurcating around the annulus on the other side. Circulae of the posterior field, since they are evenly and widely spaced, should not be used as the only criteria for locating the annulus.

GROWTH AND SEXUAL DIMORPHISM

On plotting the growth at each age for each sex, it was decided to lump all the specimens throughout the collecting period into apparent age groups. This was imperative since males virtually disappeared after June, yielding samples composed mainly of females of all ages (table 1). Males collected during this same period, June to October, were three years old.

Although both the standard and head lengths (table 3) tend to fluctuate widely between year-groups 1 and 3, there is a general decrease in growth increment of 50 percent annually. Apparently a change in the growth rates of both sexes occurs somewhere between 35 and 50 mm standard length. Female dace (table 3) weights were noticeably heavier for all ages except year-group 2 where males slightly exceeded females in weight.

Pectoral fin lengths, however, for all specimens are always longer for males than for females. In a comparison of the ratios of head length and pectoral fin length to the standard length and to each other by age and sex, it is evident that the pectoral fin length in head length ratio is the best and least variable criteria by which one can readily sex redside dace throughout the year (table 4). A

1.15 to 1.19 (male) and 1.36 to 1.41 (female) pectoral in head length ratio exists for year groups 2 to 4. The same comparative ratios for year class 1 are 1.38 for males and 1.44 for females, respectively. The pectoral length in standard length ratio can be used secondarily to distinguish between sexes beyond year-group 1; however, the range of variation is often enormous. For this reason this criterium should be used cautiously. Genital papillae, although tubular and/or rigid ventrally and of varying lengths within sexes, should be used sparingly as a sex recognition character at other than the breeding season.

TABLE 3

A comparison between mean standard, head and pectoral fin lengths and weights for various age groups of Clinostomus elongatus *(Kirtland) from Linesville Creek, Crawford County, Pennsylvania*

	Year Groups							
	1		2		3		4	
	Male	Female	Male	Female	Male	Female	Male	Female
Number of specimens	25	93	12	66	12	19	2	4
Standard Length—Mean	39.08	39.70	57.35	54.79	66.43	68.54	74.50	74.56
Standard Deviation	3.59	5.50	4.52	5.17	2.86	2.23	3.90	4.41
Head Length—Mean	10.56	10.45	15.20	14.40	17.10	17.98	18.53	19.63
Standard Deviation	1.33	1.79	1.68	1.84	1.37	1.39	.5	.5
Pectoral Length—Mean	7.68	7.25	12.94	10.60	14.41	12.84	16.16	13.96
Standard Deviation	1.19	1.25	1.64	1.49	.69	1.08	.77	.45
Weights	1.05	1.20	3.09	2.91	4.76	5.81	5.70	7.28

TABLE 4

A comparison of ratios of body proportions of Clinostomus elongatus *(Kirtland)*

	Year Group							
	1		2		3		4	
	Male	Female	Male	Female	Male	Female	Male	Female
Head Length in Standard length	3.70	3.80	3.77	3.80	3.88	3.81	4.02	3.80
Pectoral Length in Standard Length	5.09	5.48	4.43	5.16	4.61	5.34	4.61	5.34
Pectoral Length in Head Length	1.38	1.44	1.17	1.36	1.19	1.40	1.15	1.40

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SUMMARY

Two hundred and thirty-four specimens of *Clinostomus elongatus* from Linesville Creek, Crawford County, Pennsylvania, were sampled for studies of food, growth and sexual dimorphism during 1955.

The food of the redside dace consisted of 76.9 percent terrestrial insects. Seventeen percent of the total volume was composed of bottom forms such as Diptera pupae, Ephemeroptera and Odonata. Only a little over four percent of the food consisted of groups other than insects such as arachnids, hydracarina and plants.

Diptera formed the greatest quantity, 27.7 percent volume, and the most frequent food item in the diet. Other orders, such as Coleoptera and Hymenoptera contributed the next greatest quantities as food items.

A shift in the size and quantity of food was noted from that of Diptera to Coleoptera and Hymenoptera during different months of the year and by age groups. Older fish tend to feed on larger organisms than fish one year old.

Much variation exists in the standard and head lengths of redside dace; however, a general growth-increment decrease of 50 percent annually was noted.

Annuli are laid down by October 25 while circuli formation is evident as early as March 4.

The annulus is a clear zone best seen in the anterior field of the scale and delineated on the sides by successive circulae running together to form one prominent circulae within the posterior field.

Pectoral fin lengths can be used with certainty at all times of the year as a means of distinguishing between sexes. Male fins for all specimens and year groups are longer than female fins. A general relationship of 1.15 to 1.19 (males) and 1.36 to 1.41 (females) exists for the pectoral in head length ratio of fish 2 to 4 years old.

The pectoral fin in standard length ratio may be used cautiously as a recording means of distinguishing between sexes.

The use of genital papilla shape and length should be used sparingly as only during the breeding season are they distinct. Throughout the remainder of the year their shapes may be rigid or tubular in either sex.

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